Journal of the Bombay Natural History Society, 101 (2), May-Aug 2004 227-234

ELEPHANT-HUMAN CONFLICT ON COMMUNITY LANDS IN GARO HILLS, NORTHEAST INDIA[1]

A. Christy Williams[2, 3] and A.J.T. Johnsingh[2,4]

[1]Accepted June 2002
[2]Wildlife Institute of India, P.O. Box 18, Chandrabani, Dehra Dun 248 001, Uttaranchal, India.
[3]Email: acwill69@yahoo.com
[4]Email: ajtjohnsingh@wii.gov.in

An assessment of elephant-human conflict was carried out in the Garo hills in northeast India from November 1994 to September 1995. More than 85% (*c.* 3,605 sq. km) of the estimated elephant habitat is under the control of village communities. The predominant land-use pattern on these community lands is slash and burn agriculture, locally known as *jhum*. Our results showed that West Garo Hills district was the area most affected by elephant depredations. The landscape pattern resulting from the practice of slash and burn agriculture creates a mosaic of crop fields and forests. Since the forest patches in these areas are too small to support elephant groups for long periods of time, they move from one forest patch to another through crop fields and this leads to crop raiding, the main form of elephant-man conflict. The economic cost of damage caused in the region has been compared with similar studies in India. Reasons for crop raiding and the effectiveness of the current mitigation measures are discussed. The number of elephants killed by humans, either during crop raids or by poaching, has gone up in recent years. Recent developmental practices, like mining, which are incompatible with elephant conservation, are becoming widespread across the landscape, and are likely to increase the rates of elephant-human conflict. Recommendations to understand and reduce the conflict are outlined.

Key words: *Elephas maximus*, elephant-human conflict, crop raiding, shifting cultivation, northeast India

INTRODUCTION

The Asian elephant *Elephas maximus* in India occurs in five major fragmented populations totalling 17,000 to 22,000 individuals (Daniel 1980; Sukumar 1991). The elephant populations in south, central, and northwest India occur primarily in Forest Department controlled reserved forests, wildlife sanctuaries and national parks. However, in northeast India, a significant proportion (>40%) of the elephant population occurs in community lands, otherwise known as unclassified state forests. Most of elephant-human conflict studies in India have looked at elephants living within protected areas or areas controlled by the Forest Department, going out and causing crop depredations and loss of lives. However, in northeast India, elephants are living in areas controlled by local communities, and therefore traditional methods of management to reduce or mitigate the conflict are not feasible. This study is the first in India to analyse the problem of elephant-human conflict on community lands.

The Garo Hills, in Meghalaya, are a region of high elephant density and elephant-human conflict. An estimated 1,400 elephants occur over 3,605 sq. km of forest, of which only 15% is under the control of the Forest Department (Anon 1994). The 1993-94 Forest Department census estimated the total number of elephants on community lands, managed by tribals, to be over 600 (Anon 1994). This census was carried out when forests were cleared for cultivation. During such times elephants retreat to Forest Department controlled forests where disturbances are less, and therefore the estimate for community lands could be low.

The majority of the people living in the Garo Hills belong to the Garo tribe. Each Garo village has its own forests, demarcated by landmarks, such as streams and ridges. The control and management of the forest in every village is under the headman who acts in close coordination with the villagers (Singh 1994). The majority of the Garos subsist on shifting cultivation (*jhum*), a traditional method where a patch of forest is chosen and cleared by slashing the undergrowth and felling small trees and bamboo. The larger trees may be left intact. The felled vegetation is burnt when it is dry and the cleared area is divided into plots. Each plot is allotted to a family for cultivation. The area is cultivated for one or two years, after which it is abandoned and the people move on to another patch of forest to repeat the process. A special clause in the Indian Constitution allows them to practice *jhum* till date.

Approximately 760 sq. km of community forests is estimated to be under shifting cultivation or *jhum* in Meghalaya (Husain 1981). This has created a mosaic of secondary (bamboo and degraded scrub) forests interspersed with cultivation and primary forests. As a result, elephants often encounter crop fields, which have little or no protection, and raid them as the crops provide an easy source of highly nutritious food (Sukumar 1991). While attempting to prevent crop raiding, there are injuries and loss of human lives every

year. To compensate this depredation, in 1984 the Forest Department started paying monetary compensation to the victims (Meghalaya Forest Department Office Memorandum No. For. 58/83/172 dated 25th April 1984). This measure has not contributed significantly towards reducing the problem of elephant-human conflict (see Results). Since the launching of Project Elephant, in 1991-1992, a Government of India project for the conservation of elephants in India, there is a renewed interest in implementing long-term measures to reduce elephant-human conflict.

Understanding the extent and intensity of the elephant-human conflict is important to formulate and implement mitigation measures (Thouless 1994; Desai and Krishnamurthy 1992) for this and similar areas in northeast India and Southeast Asia. The perspective of the local people needs to be assessed to come up with workable proposals. In this paper, we discuss the intensity of elephant-human conflict in Garo Hills and the efficacy of the various mitigation measures. Data was collected during a status survey of elephants in the region from November 1994 to September 1995.

The study area and land use in Garo Hills

The Garo Hills are one of the hill ranges in the northeast Indian state of Meghalaya, the other ranges being the Khasi Hills and Jaintia Hills. Garo Hills lie between 25° 9'-26° 1' N and 84° 49'-91° 2' E. The region includes three districts, namely the West Garo Hills, the East Garo Hills, and the South Garo Hills, covering a total area of 8,197 sq. km(Fig. 1). It is bordered on the west and the north by the Assam plains and on the south by the Bangladesh plains, while on the east the Garo Hills merge with the Khasi Hills. The average altitude is about 600 m and Nokrek peak, the highest point in Garo Hills, is 1,412 m (Momin 1984). The annual rainfall ranges between 1,500 and 3,500 mm. The human population density in the elephant areas of the three districts ranges from 23 to 106 /sq. km (Anon 1992). Haridasan and Rao (1984) have classified the vegetation into tropical evergreen forests, tropical moist deciduous forests, savannas, and bamboo forests. The last two categories are secondary forests characterised by abandoned *jhum* areas.

The predominant form of land use in the Garo Hills, as mentioned earlier, is *jhum*. Farmers grow rice, cotton, ginger, chillies, millets, tapioca and various types of gourds and vegetables. Intercropping and sequential harvesting are a characteristic feature. The area of each *jhum* plot ranges between 1 and 2.5 ha, depending on the size of the family. *Jhum* agriculture is rainfed and subsistence farming is the norm. The farmers return to a site after 5-10 years (Ramakrishnan 1992). The *jhum* fields may lie as far as 1.5 to 2 km from the village and are surrounded either by degraded *jhum* fallows, bamboo forests, older secondary forests or by patches of the above forest types. There may be small patches of primary forests nearby, mainly along the streams.

METHODS

The Forest Department of Meghalaya receives complaints of elephant depredation cases and files these reports. All the data (N = 23,755 cases), which are computerised for the years 1984-1993, were used to quantify elephant depredation cases that occurred in Meghalaya in general and Garo Hills in particular during this period. Each record contained the name of the village, the farmer, the crops raided and the compensation claimed/ estimated. Besides, elephant post mortem reports and ivory records, collected from dead elephants in the field or seized from poachers, were obtained from the Wildlife Division Offices of the three districts. To get a quantitative measure of the economic losses due to crop raiding and to evaluate the peoples' attitudes, an intensive survey of 18 affected villages in West Garo Hills was conducted in August 1995. The villages (about 2% of the total villages in the elephant range in this district) were chosen randomly. The sub-divisional Government Officer in-charge of the division who was responsible for paying compensation told us that these 18 villages were representative of the villages in the area.

To quantify crop damage, costs were calculated by approximating the field damaged to the nearest geometrical shape (e.g. rectangle or square) and taking relevant measurements to calculate the area of damage. Five to twenty-five 1 sq. m quadrats were laid, depending on the area damaged (i.e. 5 size classes <500 sq. m, 500-1000 sq. m, 1000-1500 sq. m, 1500-2000 sq. m, >2000 sq. m), to determine the percentage of clumps (e.g. paddy, since it is planted in clumps) or plants (e.g. maize) damaged per unit quadrat area. This was extrapolated for the damaged area. Yield per hectare for crops like paddy, cotton and ginger were obtained from the local agriculture office to calculate the cost of damage. Cost of production (i.e. number of man hours spent growing and guarding the crops) could not be calculated and therefore costs of damage due to raiding are underestimates for crops. For houses, huts, and arecanut plantations, the initial establishment costs and the number of man days spent in constructing the hut, house or raising the plantation were ascertained to arrive at the actual cost of damage. Wherever possible, the identity of the marauding elephants was established by locating tracks and enquiring with the villagers who kept watch on their fields from hides built on trees.

The number of families in the villages ranged from 13 to

90 (mean = 38 and S.D. = 21, n = 18). As village activities are coordinated at the community level, we found it appropriate to conduct an informal interview based on a questionnaire with the village headman, or in his absence, a village elder, about their opinion on the elephant-human conflict. Questions were asked about land-use patterns (e.g. are they shifting cultivators or permanent cultivators?), compensation scheme (e.g. Does the Government pay compensation in time and are they satisfied?), preventive measures etc. Hereafter, the term "respondents" will be used for the village headman/elder. It was not possible to get responses from other villagers due to the social set up. Forest cover maps of the Forest Survey of India (1:2,50,000), based on satellite imagery, were digitised on Unix based GIS software GRASS 4.0 to quantify the area of the dense forest (>40% canopy cover) patches in and around the villages surveyed.

RESULTS

Crop raiding and property losses

The Garo Hills are an area of high elephant and human density (Table 1). Between 1985 and 1993, Garo Hills accounted for more than 86% of the depredation cases (Table 1) for which the Government of Meghalaya paid compensation. Crop damage was the main form of elephant-human conflict, and *c.* 95% of the total cases filed to date record damage to crops and households.

To determine the spatial distribution of the conflict within Garo Hills, we analysed the number of depredation cases filed between 1993 and 1995. West Garo Hills district which has the highest human density is a seriously affected region in the area (Fig. 1), accounting for 83% of the total cases (Table 2). The risk of being raided by elephants in West Garo Hills was higher than in other districts (Table 2). Most cases of

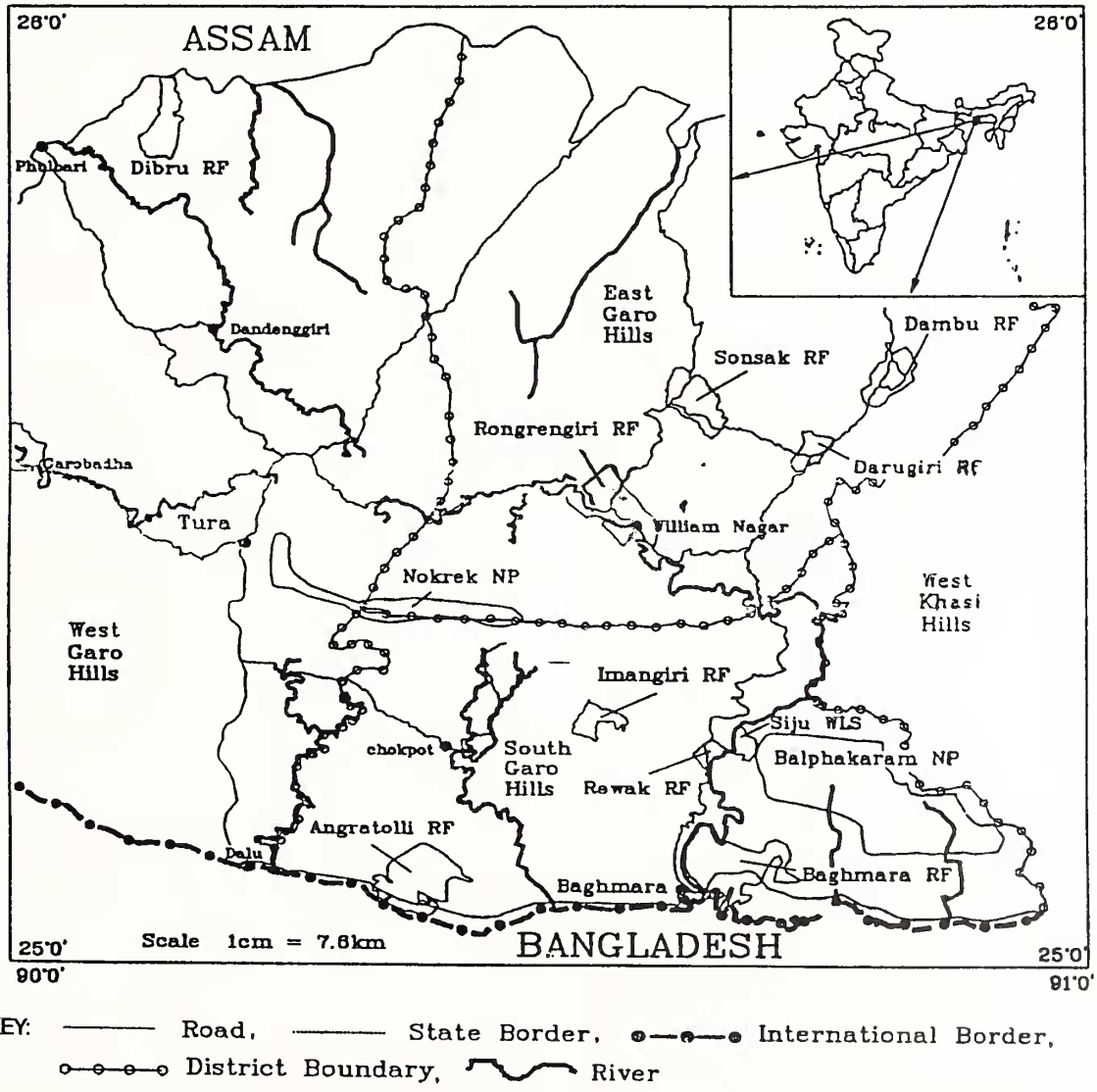

Fig. 1: Map of Garo hills showing Reserve Forests (RF), districts, roads, rivers and important towns

Table 1: Estimated population of elephants, approximate human population, geographical area, estimated elephant habitat and elephant depredations in the three hill ranges of Meghalaya

	Hill range		
	Garo	Khasi	Jaintia
Geographical area (sq. km)	8,167	10,443	3,819
Rural human population	602,936	630,138	198,473
(No. /sq. km)	(74)	(60)	(52)
Elephant habitat in sq. km	3,605	2,913	925
Elephant population	1,460	742	20
No. of depredation cases (1984-93)	20,576	3,082	97
Percentage of cases	86.6	13	0.4

Source of information: Anon (1992, 1994), Williams & Johnsingh (1996), Tayeng (1981)

Table 2: Number of crop depredations by elephants, approximate number of families, human density, estimated elephant habitat, crude elephant densities in the Garo Hills between 1993-95

	Districts		
	South Garo	East Garo	West Garo
Crop depredations	780	282	5147
Human families	7957	5150	21,843
Human density (No. /sq. km)	22.9	36.4	106.7
Elephant habitat (sq. km)	1805	735	1065
Crude elephant densities (No. /sq. km)	0.51	0.50	0.16
Crop depredations / 100 families / year	4.90	2.73	11.78

depredations in West Garo Hills district occurred between June and December, with high peaks in July and August, and a lower peak in November (Fig. 2). These peaks coincided with the ripening of paddy in July and August, and availability of cotton flower buds in November.

Thirty-eight reported elephant depredation cases were investigated, out of which 28 were found to be authentic and 78% of the authentic cases were of crop raiding. The area damaged per case ranged from about 50 to 5,470 sq. m (Mean = 731.20 and S.D.= 1341.49, n = 18). Raiding was mainly for paddy (41%) and ginger (41%). Other plants damaged were cotton (9%), tapioca, maize and pineapple. Paddy, maize and tapioca were the plants eaten while ginger, cotton, tapioca and pineapple were destroyed due to trampling. Elephants also damaged arecanut trees by pushing them down. Out of 21 cases, where the raiders could be identified by following and sizing up footprints, 90% were by female groups with calves. Huts in the *jhum* fields were often destroyed during raids. During July and August 1995, nine *jhum* huts and a house were destroyed in the 18 sample villages. The estimated cost of damage per case ranged from Rs. 400/- to Rs. 5,288/- (US $ 11.7 to 154.6) [mean = Rs. 878.6 (US $ 25.7), S.D. = Rs. 1,417.7 (US $ 41), n = 29]. There is severe restriction on the movements of villagers once the elephants come into the vicinity of their villages.

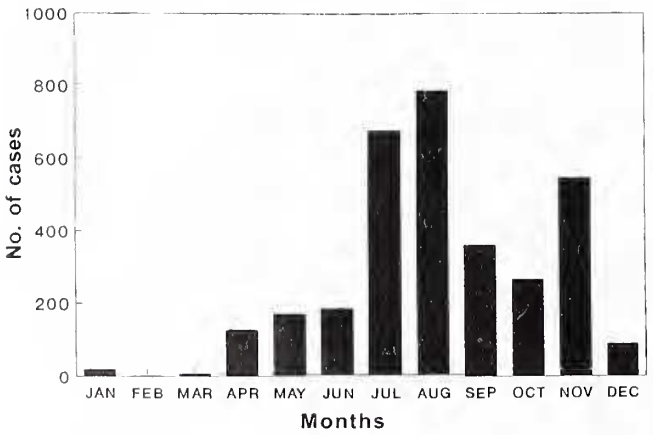

Fig. 2: Crop raiding cases registered in West Garo Hills district in 1990-1991

Elephant related human deaths and injuries

Seventy-four percent (n=65) of all deaths and 90% (n=62) of all injuries caused by elephants in Meghalaya between 1984-1995 were recorded in the Garo Hills. West Garo Hills consistently recorded the maximum number of elephant related injuries and deaths (Table 3). However, the risk of death or injury was higher in the South and East Garo Hills than in the West Garo Hills (Table 3). Deaths or injuries were caused while protecting crops, or during chance encounters with elephants on forest trails, or when some bulls turned rogues and trampled people in their huts at night.

Table 3: Human deaths and injuries caused by elephants in the three districts of Garo Hills between 1984 and 1995

	Districts		
	South Garo	East Garo	West Garo
Deaths / injuries	13[a]	28	74
Approximate human population in the elephant areas	41,370	26,780	113,583
Total deaths or injuries/ 1000 people/year	0.1	0.1	0.06

[a] - South Garo Hills district was created in 1992-93 by dividing West Garo Hills district and hence calculations were done only for that period

Table 4: Places where elephant related injury or death occurred

Place	Men	Women
Village area	11	5
Forest trails	19	6
Protecting crops	8	0
Total	38	11

The exact identity of the elephants responsible for deaths and injuries is not available. Where the circumstances leading to deaths and injuries caused by elephants between 1985 to 1995 could be ascertained, it was found that most occurred when elephants were encountered accidentally along forest trails (Table 4). More men were killed or injured than women irrespective of where the death occurred (Table 4).

Once an elephant is declared a *rogue*, license to shoot it is granted to anyone who is competent to do so. Even after the animal has been declared a *rogue*, efforts to get rid of it have not always been successful. Between 1985 and 1994, only 3 out of the 7 animals declared *rogues* could be killed.

Costs to elephants

As an alleviation measure for people suffering from elephant depredations, hunting licenses to shoot elephants used to be issued till 1981 (Gogoi and Choudhury 1982); between 1961 and 1981, a total of 226 elephants had been shot (Lahiri-Choudhury 1985). However, with passing of the Wildlife (Protection) Act 1972, capturing was completely banned and only a few exceptions have been made. Forty-three percent of the elephants (n=32), for whom post mortem or ivory records were available, died due to human related causes (e.g. speared or shot) between 1984 and December 1995 (Table 5).

All the villagers consider elephants as the property of the Forest Department. They were aware that shooting elephants is an offence and therefore, many of the respondents were not willing to answer the question whether they shoot at elephants that raid crops. Data shows that they do shoot (Table 5). There has been a sharp increase in the number of elephants killed in 1995 as compared to the previous years (Table 5). People in possession of ivory from elephants poached in Garo Hills have been arrested in the last two years. In August 1995, 6 pairs of tusks were seized in Tura, the most populous town in Garo Hills.

Trends of change in land use

In West Garo Hills, the respondents from 89% of the villages (n=18) surveyed said that the *jhum* cycle has been decreasing. Eighty-three percent of these villages had a *jhum* cycle of less than 10 years. Most of the respondents (94%) concurred with the view that the current level of *jhum* was unviable and were willing to try alternate methods of farming if proper guidance and support were provided.

Elephants are also present in the coal and limestone deposit rich East and South Garo Hill districts. During this study it was noticed that some of these areas were being mined for coal on a small scale to check the viability of mining. An area of 2 sq. km adjacent to the Rewak Reserve Forest (Fig. 1), a crucial elephant corridor in South Garo Hills, has been leased out by the villagers managing this area for mining limestone on a large scale. This corridor is an important passage for elephants and gaur *Bos gaurus* crossing over from the Balphakaram National Park in South Garo Hills district to the Angratolli Reserve Forest (RF) and Nokrek National Park area (Fig. 1) and back (Williams and Johnsingh 1997b). According to the Forest Department census conducted in 1993, this corridor connects a population of about 600 elephants on the left bank of River Simsang to about 250 elephants in the Nokrek NP-Angratolli RF area (Fig. 1). A cement factory ancillary to the limestone quarry and a housing settlement for the factory workers has also been proposed in and around this corridor area. The use of the corridor by elephants would then not be possible and the gene flow would stop if the above proposal is implemented (Williams and Johnsingh 1997b). This could result in the elephants trying to cross through alternate routes, which are heavily populated, resulting in increased incidents of elephant-human conflict.

Table 5: Reported elephant deaths from Garo Hills

Cause	1984-93	1994	1995
Unknown	14	3	2
Speared/shot	1	0	4
Poached	0	1	7
Total	15	4	13

Mitigation measures

Compensation: A total of Rs. 12,130,805 (US $ 391,300) was paid as compensation for elephant depredations on crop and property in Meghalaya between 1985 and 1993. When a compensation claim is filed, the Forest Department staff is required to inspect and assess the damage. Due to shortage of manpower and logistical problems, the process is time consuming. The claims for the year 1993 were yet to be settled in 1995. If a person was killed outside the land controlled by the Forest Department, compensation amounting to Rs. 10,000 (US $ 330) was paid. Various amounts were paid depending on the severity of the injuries. A total of Rs. 5,96,400 (US $ 19,200) was paid as compensation for the loss of lives and injuries between 1984-85 and 1992-93. No compensation was paid in cases when the death or injury occurred inside Forest Department controlled forests.

Of the 18 villages surveyed, only 15 had received compensation for elephant depredation between 1984 and 1993 at least once. The respondents in all the villages (n=18) were unhappy with the compensation scheme. The scheme is also open to abuse as 26% of the reported depredation cases (n=38) checked were found to be false. Only one out of the fifteen villages, where compensation had been paid earlier,

wanted continuance of the scheme as a mitigation measure in its present form.

Preventive measures: The methods used to ward off elephant raids were similar in all parts of Garo Hills. Shouting, beating tins, and brandishing burning torches were commonly used. Villagers said firing gun shots over the heads of the elephants only resulted in their retreating for a short distance, or in some cases had no effect.

Eighty-nine percent of the respondents said that the number of elephants has increased noticeably. When asked for a reason for the apparent increase, 44% of the respondents blamed stopping of elephant capture. Till 1981-82, the Forest Department of Meghalaya used to capture elephants from different elephant areas of the state. A total of 1,298 elephants were captured in Meghalaya between 1960 and 1981 (Lahiri-Choudhury 1985) by the traditional *mela shikar* method.

Asked for their opinion on mitigating elephant-human conflict, 28% of the respondents wanted elephants to be removed from their area. Other suggestions were paying compensation (16%) and electric fencing of their land by the Government (16%). The rest were unsure and wanted the Forest Department to take action to reduce crop depredations. All the respondents were eager to try any method that might reduce their losses.

DISCUSSION

Elephant-human conflict is fast emerging as an important issue in the Garo Hills, especially in the West Garo Hills district. Most of the conflict is due to crop raiding. An average of 11.74% families are affected in West Garo Hills every year (Table 2). The estimated total cost of damage caused by elephants for the 28 authentic cases was Rs. 24,600 (US $ 683) or Rs. 880 (US $ 24) per case. This means that the affected families lose about 8% of their annual income, which is about Rs. 11,000 (US $ 305). The damage caused is comparable to the results obtained by Sukumar (1991) who reported that the cost of elephant depredations was US $ 21 per family, and the total damage caused by 200 to 250 elephants amounted to US $ 18,960. In another study on crop raiding patterns in central India, the total damage caused to 10 large villages by about 65 elephants was estimated to be around US $ 5,000 (Datye and Bhagwat 1995). In West Garo Hills, on an average, 2000 cases are reported every year. If 75% of these cases are true, the total damage caused by a population of 160 elephants is around Rs. 13,17,000 (US $ 36,000) per annum.

Several reasons have been given to explain crop raiding (McKay 1973; Olivier 1978; Sukumar and Gadgil 1988; Santiapillai and Widodo 1993). Fields that have highly nutritious crop would attract elephants living in patchy and degraded environments. The West Garo Hills have various sizes of secondary and primary forests, in various stages of degradation, scattered with *jhum* fields. A few valleys have permanent cultivation. Patches of forest, classified as dense forest (see methods), in and around the surveyed villages, ranged from 1.12-16.26 sq. km (mean = 5.62 sq. km). The smallest known home range of an Asian elephant bull is 32 sq. km (Olivier 1978) and that of a female group is 34 sq. km (Joshua and Johnsingh 1995), and it is unrealistic to expect the small patches in West Garo Hills to provide elephants all their ecological requirements. Therefore, they are forced to move from one patch to another. During such ranging the newly created *jhum* fields in the vicinity with extremely palatable and nutritious crops are raided. This was noticed in another study on elephant-human conflict in southern India (Nath and Sukumar 1998). Female groups with calves and juveniles tend to avoid areas with high risks, like being fired at or chased with fire torches. The fact that a number of raids on *jhum* fields were carried out by groups indicates that the risks here are possibly low.

For preventive measures, like electric fencing or trenching, to be effective, it is important to understand which areas are raided and why certain crop fields are raided more than others. Crop fields near traditional routes may be raided more often than other fields. Therefore, a study using radio telemetry to understand how elephants find resources to survive in an environment that can change dramatically every one or two years due to *jhum*, has to be taken up immediately. It may be possible to predict elephant movements (Ekobo 1997) and therefore vulnerability of the various crop fields to raiding by elephants. Electric fencing may work in areas of permanent settled agriculture as in Zimbabwe (Taylor 1993), but not in areas of shifting agriculture. Therefore, the management should work to wean away the tribals from *jhum*.

In Meghalaya, the human population has undergone an eleven-fold increase between 1881 and 1991 (Tayeng 1981; Anon 1992). Ramakrishnan (1992) states that a *jhum* cycle of at least 10 years is considered necessary for the *jhum* to be viable economically and energetically. This can happen only when the human population density remains low. The current high human densities in West Garo Hills (Table 2) have already shortened the *jhum* cycle to less than 10 years. If the human population continues to grow at the current rate (*c.* 3.2% per year), elephant-human conflict is bound to increase. Elephant conservation may finally depend on how effectively we curb the growth of the human population and its dependence on *jhum* agriculture, which lies outside the scope of wildlife management agencies. An integrated approach, involving the local administration and non-governmental organisations

(NGOs) is required for conservation efforts to be successful. These agencies should introduce alternate sources of livelihood like piggery, small pond fisheries and bee keeping, and family planning education. Otherwise, as Hoare (1998) predicts, the threshold of land cover transformation will be reached, resulting in the disappearance of the elephants from their natural habitat.

Many lives are lost while protecting crops or property from elephants. More men are killed than women, as men encounter elephants more often in their day-to-day life. This was also observed in other elephant-human conflict areas in south and central India (Sukumar 1991; Datye and Bhagwat 1995). When a bull turns into a rogue, killing and damage to property rapidly increases in its range. A general fear psychosis builds up among the villagers when a rogue wanders around in the vicinity of the village. Due to logistical and bureaucratic delays, it takes time for a rogue to be identified, declared a rogue and shot. This results in further loss of lives and property. Decentralisation of this process with the involvement of the local Divisional Forest Officer may help to speed up the process of eliminating the rogue.

Compensation raises the tolerance threshold of affected people for species like elephants that can cause huge economic damage (Tchamba 1995, 1996). The compensation scheme was put into practice without proper planning and logistical support. The forest department lacks adequate staff to verify the claims. Therefore, some people are misusing the scheme by filing false claims. The scheme is also tied up in bureaucratic delays, and payment for verified claims is delayed for years. It is not surprising, therefore, that there is widespread dissatisfaction among the villagers, both with the amounts paid and the delays in the scheme. Nevertheless, a limited investigation showed that a number of genuine compensation claims (approx. 74% of the cases) are filed every year, illustrating the ineffectiveness of the deterrence methods in use. There is no one fool-proof method of preventing elephant depredations (Thouless and Sakwa 1995) and the best option may be to try different methods. Elephant capture can help to control the problem and it should be resorted to in places with severe crop depredations.

It is likely that in an industrially backward state like Meghalaya with low per capita many more areas will be taken up for mining limestone and coal. A few of these areas constitute some of the best elephant habitats or they lie in crucial corridor areas. Elephant-human conflict therefore is bound to increase as economic interests dictate the exploitation of these areas. It is still possible for the government to acquire large tracts of land as the price of land (*c.* US $ 7000/sq. km) is relatively low. Therefore, funds will have to be raised to acquire crucial areas like corridors or primary elephant habitat which lie in these mineral rich zones.

Until recently, very few cases of elephants killed by humans were reported. But the spurt in elephant deaths, between January and December 1995, due to humans, and the ivory seizures indicated that the situation could worsen if not tackled immediately. Till 1995, most of the deaths were due to gunshot or spear wounds received while crop raiding. However, since 1995 most of the elephants killed have been tuskers, and ivory seizures also indicate increase in poaching. Menon *et al.* (1997) reported that there exists a sizeable underground trade in elephant meat and a few seizures of processed elephant meat points to the worrying conclusion that even a female may not be spared if she gets out of control. One of the main problems in Garo Hills is the lack of manpower and money to carry out effective conservation of elephants on community lands. It may be a cheaper and more beneficial long term management solution to concentrate efforts in closing down the trade in elephant meat.

The problem of elephant-human conflict is assuming serious proportions in Garo Hills. Most people express dissatisfaction over the efforts taken by the Government to solve the problem. For Meghalaya, a modest goal of reducing elephant depredation by 20% to 30% in the next three to four years would do much to convince the people about the efforts taken by the Government to control the problem (Williams and Johnsingh 1997a, b, c). The Garo Hills elephant population is one of the two populations in northeast India, which seem to have the minimum numbers to be viable in the long run. The elephants in northeast India have been genetically isolated from the other elephant populations in India for a long time. Therefore, from a conservation point of view, they are most important. The lessons we learn in Meghalaya, in the process of reducing costs to both elephants and humans, are going to prove invaluable for conservation in India and elsewhere in Southeast Asia and Africa where the land use patterns are similar.

ACKNOWLEDGEMENTS

This project was conducted by the Wildlife Institute of India (WII) for Project Elephant. We thank the Directors of WII and Project Elephant for the support extended to successfully complete the project. Our sincere thanks to Mr. Balwinder Singh, Mr. S.B. Singh, Mr. Tony Marak and other officers and staff of the Meghalaya Forest Department for support during the survey. We thank Wesley for helping design the crop damage assessment methodology and Ratna Singh for help with analysis of the crop damage database. We thank Charudutt Mishra, M.D. Madhusudanan, Nima Manjrekar, Ravi Chellam and T.R. Shankar Raman for commenting on the manuscript.

REFERENCES

ANON (1992): Statistical Handbook. Directorate of Economics and Statistics, Shillong, India. 221 pp.

ANON (1994): Meghalaya Project Elephant Document. Wildlife Wing of Meghalaya Forest Department. Shillong, India. 115 pp.

DANIEL, J.C. (1980): Introduction. Pp. 7-8. *In*: Status of Asian Elephant in the Indian subcontinent (Ed.: Daniel, J.C.). IUCN/SSC report, Bombay Natural History Society, Bombay.

DATYE, H.S. & A.M. BHAGWAT (1995): Estimation of crop damage and economic loss caused by elephants and its implications in the management of elephants. Pp. 375-388. *In*: A Week with elephants (Eds: Daniel, J.C. and H.S. Datye). Bombay Natural History Society, Bombay.

DESAI, A.A. & V. KRISHNAMURTHY (1992): Elephants in Meghalaya State, India: Status, Conservation and Conflict with Agriculture. Pp. 9-13. *In*: The Asian Elephant (Eds: Silas, E.G., N.M. Krishnan and G. Nirmalan). Kerala Agricultural University, Trichur, India.

EKOBO, A. (1997): Elephant problem in the Mungo Division, Littoral Province (Cameroon). *Pachyderm 24*: 53-63.

GOGOI, P.C. & D.G. CHOUDHURY (1982): Report on elephant census in Meghalaya. *In*: Elephant (*Elephas maximus*) management in the wild and captivity. IUCN/SSC Asian Elephant Specialist Group, NE India Task Force Report, Jaldapara, India. 7 pp.

HARIDASAN, K. & R.R. RAO (1984): Flora, vegetation and plant resources of Garo hills. Pp. 15-39. *In*: Garo Hills: Land and the People (Ed.: Gassah, L.S.). Omsons Publications, New Delhi.

HOARE, R. (1998): Human-elephant interaction at the ecosystem level. *Pachyderm 25*: 41-42.

HUSAIN, M. (1981): Shifting cultivation in the north eastern region of India - an ecological problem. *Proc. Int. Congr. Neth. Soc. Landscape Ecol.* Veldhoven. Pp. 125-130.

JOSHUA, J. & A.J.T. JOHNSINGH (1995): Ranging patterns of elephants in Rajaji National Park: Implications for reserve design. Pp. 256-250. *In*: A Week with Elephants (Eds: Daniel, J.C. and H.S. Datye). Bombay Natural History Society, Bombay.

LAHIRI-CHOUDHURY, D.K. (1985): Elephants in north-east India. Pp. 7-17. *In*: The Status of the Asian Elephant (*Elephas maximus*). IUCN/SSC Asian Elephant Specialist Group Report, Bandipur, India.

MCKAY, G.M. (1973): The ecology and behaviour of Asiatic elephant in south eastern Ceylon. *Smithsonian Contrib. Zool. 125*: 1-113.

MENON, V., R. SUKUMAR & A. KUMAR (1997): A God in Distress: Threats of Poaching and the Ivory Trade of the Asian Elephant in India. Asian Elephant Conservation Centre, Bangalore, India. 91 pp.

MOMIN, P.G. (1984): Physical setting of Garo hills. Pp. 15-39. *In*: Garo Hills: Land and the People (Ed.: Gassah, L.S.). Omsons Publications, New Delhi.

NATH, C. & R. SUKUMAR (1998): Elephant-Human Conflict in Kodagu, Southern India: distribution patterns, peoples perceptions and mitigation methods, Asian Elephant Conservation Centre, Bangalore, India. 65 pp.

OLIVIER, R.C.D. (1978): On the ecology of the Asian elephant. Unpublished Ph.D. thesis, University of Cambridge. 454 pp.

RAMAKRISHNAN, P.S. (1992): Shifting agriculture and sustainable development. Man and biosphere series: V. 10. UNESCO, Paris. 424 pp.

SANTIAPILLAI, C. & S.R. WIDODO (1993): Why do elephants raid crops in Sumatra. *Gajah 11*: 55-58.

SINGH, K.S. (1994): The Scheduled tribes. Oxford University Press, Delhi. 1266 pp.

SUKUMAR, R. (1991): The Asian elephant: ecology and management. Cambridge University Press, Cambridge. 251 pp.

SUKUMAR, R. & M. GADGIL (1988): Male-female differences in foraging on crops by Asian elephants. *Animal Behaviour 36*: 1233-1235.

TAYENG, J. (1981): Census of India 1981. Series 14-Meghalaya, Paper-I of 1981. Supplement provisional population totals. Directorate of Census Operation, Ri Khasi Press, Shillong.

TAYLOR, R.D. (1993): Elephant Management in Nyaminyami district, Zimbabwe: Turning a liability into an asset. *Pachyderm 17*: 19-29.

TCHAMBA M.N. (1995): The problem elephants of Kaele: A challenge for elephant conservation in northern Cameroon. *Pachyderm 19*: 26-32.

TCHAMBA, M.N. (1996): History and present status of the human/elephant conflict in the Waza-Logone region, Cameroon, West Africa. *Biol. Conserv. 75*: 35-41.

THOULESS, C.R. (1994): Conflict between humans and elephants on private land in northern Kenya. *Oryx 28 (2)*: 119-127.

THOULESS, C.R. & J. SAKWA (1995): Shocking elephants: Fences and crop raiders in Laikipia district, Kenya. *Biol. Conserv. 72*: 99-107.

WILLIAMS, A.C. & A.J.T. JOHNSINGH (1996): A status survey of elephants (*Elephas maximus*), their habitats and an assessment of the elephant-human conflict in Garo Hills, Meghalaya. Wildlife Institute of India, Dehra Dun, India. Pp. 32.

WILLIAMS, A.C. & A.J.T. JOHNSINGH (1997a): A status survey of elephants and their habitats in Garo Hills, North India. *Gajah 16*: 43-60.

WILLIAMS, A.C. & A.J.T. JOHNSINGH (1997b): Threatened elephant corridors in Garo hills, northeast India. *Gajah 16*: 61-68.

WILLIAMS, A.C. & A.J.T. JOHNSINGH (1997c): Elephant capture in Meghalaya, northeast India – the past and the future. *Gajah 17*: 1-7.

■ ■ ■